

Lean Principles and Optimizing Flow: Case Studies

Alan D. Smith, smitha@rmu.edu

ABSTRACT

This chapter aims to provide a background on lean methodologies from its beginnings at Toyota through current applications of lean processes at local companies. Advantages of lean systems will be discussed along with the future of lean practices. Notable improvements to the lean philosophy, such as six sigma, is addressed through case studies of successful best business practices. Therefore, we need a cluster of metrics, certainly more than just cost. If we cannot adequately measure customer satisfaction and utility, we need to have more subjective ways to measure it in order to understand its complexities. Unfortunately, it is unlikely that there is a one-size-fits-all solution, I believe managers are more prone to try something that's worked elsewhere in times of crisis.

INTRODUCTION

Lean Methodologies

In theory, the ultimate goal of lean is perfection. Eliminating waste, creating value through efficiency, constructive and collective organization are themes central to lean methodology. The delicate balancing between employee satisfaction, process improvements that create value for a company, and the external needs of customers is typically the give and take struggle that lean thinking companies face. Lean manufacturing, for example, relies heavily on the use of Kanban tools for effective management of the warehousing function of supply chain management (SCM) systems. Kanban is one of the lean tools designed to reduce the idle time in a production process. In essence, lean methodologies use cards as a signaling system that triggers an action to supply the process with its needs either from an external supplier or from a warehouse (Sabry, 2010). As Kanban was originally invented as a part of the famous Toyota Production System (TPS), it is associated with the design of pull systems and the concept of delivering JIT (just-in-time) goods and services. A demand-based pull system designs processes based on customer demand. It is expected that each process produces each component based on the exact expectation of delivery from the customer. By following lean practices, it is the end goal that businesses produce only what is deliverable and processes become leaner due to reduction in excessive stock levels of raw, partly-finished, or finished materials. Hence, a demand-pull system allows management to produce only what is required at the right quantity at the right time. Ultimately, inventory levels of raw materials, components, work-in-progress and finished goods must be kept to a minimum. Management is then forced into a system that only through careful planned scheduling and flow of resources that JIT targets can be meet. Much of this

sophisticated production scheduling software to timely plan production is done through information sharing that is exchanged with suppliers and customers through a fully implemented electronic data interchange (EDI) systems.

Toyota Motor Company is often credited as the first example of a company implementing lean methodology and thinking. Toyota's penchant for lean processes can be traced back as far as 1890, before the current iteration of Toyota as we know today (Emilani, 2006). Sakichi Toyoda, an inventor, patented loom technology that greatly improved both production times and product quality. His son, Kiichiro, went on to further those advances, creating a loom that would automatically stop when a thread broke.

In 1926, Sakichi Toyoda founded the company, Toyota Loom Works (Emilani, 2006). Kiichiro worked closely with his father, and it was ultimately Kiichiro's decision to expand Toyota Loom Works to include an automobile manufacturing division. Toyota Motor Corporation was founded in 1937, backed by the forward thinking ideologies of both Kiichiro and Sakichi (Emilani, 2006).

The first formalized lean methodology was the Toyota Production System (TPS). The Toyota's forward thinking approach was helped create an environment that promoted continuous innovation and internal assessment. The two employees who are credited with creating the system were Taiichi Ohno and Shigeo Shingo (Emilani, 2006). They often attributed some of the ideas with TPS to Henry Ford and other American industrial practices. One of the most influential systems they cited was the United States's plan during World War II to increase production for the war effort, the "Training Within Industry Service" program (TWI) (Emilani, 2006).

Their influences are not meant to discredit their original ideas, as the influence from western culture was somewhat limited. They openly rejected many popular notions held by American management theorists. Toyota's employees, especially the highly influential officers, lacked formal management training (Emilani, 2006). They focused on practicality and the true nature of problems that arose in the production cycle.

The TPS system was largely developed between 1948 and 1975 (Emilani, 2006). The main objectives of the system were to eliminate waste, eliminate inconsistency and improve overall efficiency. There are two major cornerstones of TPS. First, is the actual implementation of JIT production system. This was the original concept developed by Toyota that served as the original basis of TPS and involved ordering the minimum needed quantities to reduce waste. Second is systemic processes guided by human oversight with an emphasis on keeping human involvement minimal and yet ever-present. The Toyota Way serves as the guiding principles behind the TPS system. The Toyota Way is the strong corporate culture at Toyota that focuses on continuous improvement and having sound operational processes.

The TPS system and the Toyota Way were the precursors to many different types of lean methodology. The forward thinking culture of the Toyota Way served as the template for the

characteristics a corporate culture needed to display in order to undertake a successful lean implementation. Several key concepts in lean thinking came from Toyota during this time period, such as Kaizen (continuous improvement), identifying KPIs (Key Performance Indicators), and the previously mentioned JIT inventory system (Emilani, 2006).

Offshoots of the TPS system include several newer lean methodologies. A3 serves as a form of systemic problem solving, where each outcome is planned for in advance and relies on accurate information reporting. VMS (Value Stream Mapping) uses the current business state to predict possible future business states by taking information from each step of a value chain. The Six sigma system pioneered by Motorola often cites the TPS system as its major influence. Now each company and industry has its own set of specific lean practices, but most can be traced back to the TPS system's roots.

Advantages of Lean

From its core, lean is designed to create value in each area it is applied to. This value is directly tied to the company that implements it and applied to the consumers involved as well. Value is created through the evaluation of processes that generate waste. From there companies can look ahead and plan their operations around where they want to be in the future. There are a number of typical types of waste found in the manufacturing environment. These wastes can be seen in overproduction, transportation, waiting, inventory, over-processing, defects, motion, and creativity (Idris, et al., 2013; Ketikidis, Hayes, Lazuras, Gunasekaran, & Koh, 2013; Mateen, & More, 2013). Waste can be considered anything other than the minimum amount of equipment, materials, parts, and working time which is absolutely essential to add value to the product or service.

Practicing lean can help improve quality performance by reducing the amount of defects that are created and the rework that is needed both in the warehouse and out in the field. Implementation of lean also reduces the stress placed on machines and creates fewer problems in production and in other processes. When utilized correctly, companies can see a reduction in inventory levels due to conscious efforts in operations management. From there, stock levels can begin to turn much faster because only higher moving parts are being held on the shelves. This then has benefits as well. Less inventory means the less space that is needed to store goods. Companies will be able to reduce their holding costs when less square footage is needed in their shops.

If operations are built around lean, production will flow more smoothly. There will be less waste found in assembly lines and there will be higher efficiencies. The warehouse will have more output per man hour. When workers are completing jobs at a faster rate, the customer is going to benefit from improved lead times. The great part about lean is that value transcends over to the customer and not just the business. This is the main reason why companies are moving towards these techniques.

When processes are fine-tuned and employees are spending less time fixing problems, there is a higher sense of morale to be found within a company. Perhaps, even in applying lean technologies, “The most valuable resource to any company are the people who work for it. Without these people the business does not succeed” (“Key lean manufacturing principles,” 2018, p. 1). Lean principles are designed to benefit the end user but also to increase the profits for a business and assist its employees. Processes improvements can reduce costs in ways that were not seen as achievable.

Proposition

Proposition: Lean will increase the productivity and maximize the financial profits in the manufacturing of a product.

In general, a number of researchers (Bhamu, Khandelwal, & Sangwan, 2013; Chiarini, Vagnoni, & Chiarini, 2018; Dharamdass & Fernando, 2018; Franceschini & Mastrogiacomo, 2018) have found significant benefits when monitoring their best business practices when their products which are being introduced to lean practices. The project was completed to find out whether or not lean could be a viable option for companies to mitigate costs and improve their products. The process started off with the adoption of lean production and changing the layout of the equipment to solve the production line imbalance. Production had many faults and the process was hindering overall flow.

Management typically have a need to evaluate and deduce the most optimal projects to enhance production efficiency. When coordination is set up properly, companies can develop good practices for going through production. Ultimately, tackling this approach ahead of time will prepare businesses to increase the flow of goods and be able to handle a large range of orders. In this particular situation, the company mentioned used correlation analysis methods to increase the economic benefit of enterprises.

The paths taken here were done so to create more flexibility within the company. Outside forces and unpredicted scenarios can test a company’s capabilities. When a company cannot adapt to change, it will have trouble surviving in the long run. In order to gain insight on the health of their company, the article explained the need to understand the core values in the business and be aware of what wastes are the most detrimental factors. After doing so, processes can be altered to reduce waste and essentially work on a continuously flowing basis of improvement.

What the company was able to discover was that through the adoption of lean principles they were able to meet customer expectation and occasionally exceed it as well. This result would not have been achievable if the company did not take the time to understand the issues at hand. There were certain bottlenecks that hindered the flow of goods in production. Through altering of processes and analyzation of multiple routes, the business was able to find a fitting approach for their type of business.

There are distinct differences between value added and non-value added activities that can assist or restrict a company from achieving growth and improvement. There has been considerable focus on benefits of a pull-style system. Although they are said to be difficult to implement, a pull system can be an integral part of production through replenishment pull, sequential pull, and mixed-pull systems. With the same concepts in mind to achieve a similar goal, each system is alike but with slightly varying approaches. There are multiple pieces in each system that make it distinct. It was shown to be a helpful tool when working in production.

In essence, there are extremely positive results for businesses that practice lean principles. Lean principles can provide structure and support for a large array of companies in an abundant amount of industries. Knowing that there is a difference between every company tells you that each implementation process is going to be unique. With careful evaluations and a suitable understanding of what needs improvement, lean can be a trustful approach.

Kumar, Choe, and Venkataramani (2013), documented a flailing telecommunications products company that was struggling to provide customers with accurate or acceptable lead times. The authors utilized a DMAIC approach (e.g., Define the problem, Measure, Analyze, Improve, and Control). As one might expect, the first step was to define the problem which was simply that lead times were inaccurate and often unacceptable to end customers. More frustratingly internally was that the salespeople whose sole focus is to sell goods and please customers could not get accurate lead time information from the operations groups. Lead times and other KPIs (key performance indicators) were measured so as to set a benchmark for any future improvements. The entire ordering process was then analyzed from top to bottom and critical issues were identified. One of the main issues was that certain inventories were being ordered based upon inaccurate forecasting - leading to unsuitable order sizes that became a bottleneck within the logistics system. The authors' solution was to implement a lean-pull replenishment system to cut out the noise from the logistics system and to improve overall product flow. Lastly, lead times and other KPIs were re-measured under the new system and steps were put in place to solidify the positive outcomes.

The results of the revamp of the telecommunications products company's ordering processes are impressive. Inventory turns improved as well as cost performance. Lead times were reduced to help better meet customer demand while at the same time the company's overall inventory volume was reduced thus reducing holding costs. The authors argue that utilizing a push mentality wherein production is geared towards some forecast can lead to slower lead times and destructive bullwhip effects. A lean system built around a pull model is much more beneficial and allows for less waste because items do not enter the queue until there is an actual order from a customer. The pull model more closely aligns itself to reality as opposed to a push model which is aligned with some hypothetical forecasted demand figures. Hence, the first proposition is the lean is becoming the standard by which companies need to operate under. Interestingly, Keyes (2013) found that 40% of manufacturing companies defined lean thinking as their primary business strategy, with 60% of those companies were currently using some form of lean

implementation involving continuous flow production, where machines and operators handling a continuous flow of material have a set rate of production defined by management goals.

Not only is the demand present in the workforce, driven by market demand and necessity, but also in universities as well. It is becoming expected that students have some exposure to lean prior to starting their careers. In a survey conducted by University of Wisconsin business students, 48% cited that their first employers actively used lean methodology, and 81% recognized cost savings through some form of prior or present lean implementation (Keyes, 2013).

As a result of increased emphasis on lean production methods, the National Institute of Standards and Technology (NIST) founded the Manufacturing Extension Partnership (MEP). MEP is a program that provides small and medium-sized companies with access to information and technology designed to help them in lean implementation. Some of the aspects of lean provided by MEP include RFID technology, strategic management assistance, growth planning, and nanotechnology (Keyes, 2013). Hence, many cited research efforts (Hossain & Hossain, 2018; Jain & D'lima, 2018; Oey & Nofrimurti, 2018), the typical trend that lean methodology is becoming the current standard for how a business must operate in the global operating environment.

CASE STUDIES

Industry Examples of Lean Principles

The application of lean principles into business workflow and development can be seen across many major corporations including Amazon, Wal-Mart, and Toyota. Giant corporations are not the only market participants who can benefit from the application of lean principles. Indeed, many small businesses and mid-level companies can incorporate lean principles to their current business processes to reduce waste and add value for their end customers.

A division of the MID-SHIP Group located in Western Pennsylvania, has applied lean methodologies to eliminate redundancies and reduce work hours necessary to complete tasks. MID-SHIP is a third-party logistics provider and the office in Pittsburgh acts primarily as a truck broker - matching customers with suppliers and charging a small fee for their services. As a simple example, MID-SHIP had previously run its day-to-day operations by utilizing a stale Excel spreadsheet. The spreadsheet Tracked all past, current, and future orders. Since it was simply an Excel spreadsheet, only one operations member could make any changes to the master document. This spreadsheet was emailed amongst the operations staff multiple times daily so that it could be reviewed. There was inherently wasted effort in this process. Only one person could make changes to the document, and to view a current version of the document someone with the most current version would have to take the time to email a copy to the requestor. Once the burden of this process became too much to handle - and by recognizing the potential benefits of change - MID-SHIP's management along with its technology department crafted a system that

essentially recreated the spreadsheet within MID-SHIP's own Enterprise Resource Planning (ERP) tool.

Though there were some initial headaches with regards to using this new operations tool, the benefits far outweigh the negatives. Any member of the operations team could edit any of the information in real-time. Similarly, any member of the operations team could re-run the report at any time and immediately be presented with the most up-to-date information available. By eliminating unnecessary steps, time was saved and operations visibility was significantly improved. This provided more value to MID-SHIP's customers as status updates could be provided to any inquiring customer by any operations team member at a moment's notice.

In a similar vein, MID-SHIP's accounting group - again, working closely with the information technology personnel - developed a new billing system that sped up the billing process and effectively reduced printed paperwork by 80%. In the year 2017, MID-SHIP moved approximately 20,000 truckloads of material. Nearly every one of those truckloads would be accompanied by a vendor invoice, a bill of lading, a truck release, and a rate agreement. By strictly using PDF documents, and harnessing the capabilities of MID-SHIP's ERP Dynamics AX, along with the creation of intelligent SQL Server Reporting Services (SSRS), MID-SHIP's accounting team reduced printed paperwork by about 60,000 sheets of paper in 2017 while the working-hours saved in the billing department were quite significant as well. These are just some small examples of how lean principles can be applied to almost any process and yield beneficial results. By reviewing processes, identifying wastes, and developing plans to eliminate that waste without eliminating value, firms can always find ways to become leaner which is becoming more and more important in the competitive marketplace.

Another Western Pennsylvanian business finding benefits through the use of lean principles is an exterior lighting company by the name of WE-EF Lighting USA, LLC. The relatively new company in the United States is realizing the importance of eliminating waste in order to find success. From shadow-taping tools to designing modular tables used in the assembly process, WE-EF Lighting is doing everything it can to stick to a lean methodology approach.

The recently hired CEO of WE-EF Lighting has laid out a carefully designed plan to change the way the company looks at current and new approaches. This plan involves maintaining a close eye on the future and making sure processes are lining up with lean practices.

As mentioned before, production is currently receiving the bulk of the attention at the moment. Tables were designed where employees are only making left turns while building products to reduce waste in assembly. Inventory levels were dropped significantly in order to free up cash flows for the company. Because of this, only stock items are being held in the warehouse at the moment.

Even places like the office are seeing improvements from lean. The company has engaged in a chapterless strategy that essentially plagued the employees with wasteful tactics. These wastes

included having to wait for other employees to pass on the related work. Internal processes were slowed down from this and the chapterless approach has proven to be a success.

Through the use of lean principles, WE-EF Lighting has truly gained a competitive advantage over its rivals. Process improvements start by examining the core of a company and understanding where the waste is derived from. The main focus is to work on improving the work for employees and eventually offering better products and services for consumers.

Much like WE-EF Lighting, Air Ground Xpress is another Western Pennsylvania company going through a revamping of its processes. Overall, it is attempting to undergo a youth movement, bringing in the next wave of future decision makers. The goal is to become leaner in operational techniques, while maintaining its strong market share in the Pittsburgh freight forwarding industry.

Air Ground Xpress was one of the first to use Crown Connect software, which enables customers and suppliers to share uniform information regarding shipment times, accounting details and real time updates. The most important aspect in the overhaul of processes is the EDI (Electronic Data Interchange). The technology has been around for a while, but it is an important step to keep up with competitors and meet supplier and customer needs.

Another process that was recently revamped on the accounting specific side was the methodology used to process credit card payments. It is an important part of the cash flow cycle, and plays a role in the operations of the company. For example, shipments from customs must be paid before they are released so timely payment methods are an important aspect of day to day operations. The old process involved the handling and archiving of credit card files for each customer that had to be updated constantly. Recently, this aspect of the accounting cycle was moved via API (Application Programming Interface) to the company website. Customers can now pay their cargo releases directly themselves, and credit card information storage and maintenance are taken out of Air Ground Xpress's hands. This not only saves time and input for the accounting department, but also alleviates the unnecessary risk of losing or abusing external payment information.

Lastly, the most important lean implementation that took place over the last year at Air Ground Xpress was the switch from chapter to electronic logs. JJ Keller is a company that is utilized to handle all of the important mileage, fuel and labor hours data Tracking through automatic processes enabled by transponders placed in all vehicles. Drivers now use tablets instead of chapter logs, saving both time and resources. Now each employee is not manually logging monotonous and often redundant data points. It is important to note that the switch to electronic logging was mandated by federal law as of April 2018 (hard enforcement period begins). The move was preemptively completed in Q1 2017 to ensure a Satisfactory safety rating was maintained prior to the enforcement period. This has given Air Ground Xpress a leg up in experience in terms of the systems usage with several similarly small companies scrambling to catch up in Q4 of 2017 and Q1 of 2018. Many customers have been assisted by Air Ground

Xpress in the use and implementation of JJ Keller systems and the previously mentioned Crown Connect System. Additionally, JJ Keller and Crown Connect have since collaborated to share information across both systems, furthering the efficiency of both.

Air Ground Xpress has much more work to do in the modernization of the company. However, they have begun to think forwardly in a market that is slow and resistant to change. Many important processes have been revamped and the company has gained valuable experience in successful lean implementation. Hopefully, the trend can continue in the right direction as technology in the industry advances.

Notable Improvements in the Related Area

One of the most important iterations of the original TPS lean system is the Six sigma system developed by Motorola. It was developed by Bill Smith in 1986 and trademarked by Motorola in 1993 (Yahia, 2011). The most important improvement in lean methodology is the focus on empirical data and hypothetical business states. Specifically, Six sigma does an excellent job of predicting and analyzing the number of defects in a production process. The goal with the original Six sigma process at Motorola was to ensure that processes have an allowable threshold of 3.4 defects per million process runs (Yahia, 2011). As of 2005, about 20 years after its creation, Six sigma was attributed with saving Motorola over \$17 billion (Yahia, 2011).

The success brought on by Six sigma led several other major companies to follow suit, such as General Electric and Honeywell. By 2000, almost 70% of Fortune 500 companies had adopted six sigma or their own version of it with the intent of reducing costs and waste (Yahia, 2011). It became so relevant in the business sector that the International Organization for Standardization (ISO) was created in 2011 with the first standard developed revolved around the proper use and training of the six-sigma process (Yahia, 2011).

The importance of six-sigma approaches was similar to the importance of TPS in that it was the first system to pioneer a way of thinking. TPS was the first to step back and analyze processes for continuous improvement. Six sigma was the first to analyze processes using modern statistical capabilities. It since opened the door for other empirically focused lean systems, which brought lean processes as a whole up to speed with technological capabilities today.

Future of Lean Practices

With the history of lean practices covered we now turn our focus to the future. As anyone can attest, the last 20 years have seen tremendous advancements in the realm of technology. Technological advancements are sometimes happening so quickly that by the time one item is finally mastered it has already become obsolete. The technological hardware and software are relatively expensive, so the initial capital outlays may be quite significant. While many senior managers understand the importance of technological advancements towards creating smarter, cleaner, and leaner processes, the simple fact of the matter is that many managers lack the will or the financial resources necessary to invest in the necessary technologies. Without a clear

understanding of how an investment in new technologies will result in a satisfactory return on investment, managers are often risk-averse and fearful that the investment may turn into a wasted effort.

Another key component of the future of lean processes also revolves around technology - and that is the sharing of data through EDI or other similar technological processes. Vendor managed inventory is seen by some firms as a way of reducing the burden of managing inventory and passing that responsibility along to the vendor. The vendor is pleased because they have attained a potential long-term customer. The issue here is the necessary levels of trust needed between varying firms so that information can be shared to the benefit of all involved. While this sounds excellent in theory, the simple fact remains that firms may not have the monetary resources necessary to invest in the appropriate information-sharing technologies, or firms are unwilling to trust other firms with sensitive data that may or may not damage a firm's competitive advantage.

In any case, lean processes will continue to dominate the future of production facilities and general office management overall. With firms looking to cut costs and reduce wastes at every turn, lean practices will be implemented and continuous improvement initiatives will be undertaken so that any unnecessary, non-value-adding steps in a process can be eliminated. Managers who are willing to make the financial investments in the technologies of the future will see long-term benefits from streamlined processes in the form of reduced costs and better customer service. Firms who are willing to form long-term, trusting relationships with other firms so that information can be shared will see net positive benefits overall as the sharing of information allows for better, faster decision making based upon accurate data for all companies involved.

GENERAL CONCLUSIONS AND IMPLICATIONS

Conclusion

The introduction of lean processes by Toyota fundamentally changed the way management thought about its production processes and workflow strategies. From its humble beginnings to the Toyota Production System (TPS) and beyond, the idea of lean has challenged long-held ideas regarding forecasting, push versus pull methodologies, waste in a process, and value adding activities. What began as a model for manufacturing processes has evolved into a model that can be applied to every facet of modern day business including service industries and general office administration. As demonstrated in the case studies, lean processes may be applied to any process where waste can be identified and eliminated. This helps to reduce costs and those subsequent cost-savings can be passed along to customers in the form of more competitive pricing.

Managerial Implications

Lean methodology is increasingly proving that it can benefit both companies and customers. With focuses on continuous improvement and the desire to eliminate waste, lean is designed to maximize customer values. Due to the ever-changing market environment, companies are looking towards lean as a solution to keep up with technological advancements. In an attempt to combat these changes, lean can help a company stand apart from its competitors by helping them offer superior customer service and competitive prices. Current conditions are pushing companies to adopt these processes, however, with the growth of lean, the adoption of such beneficial practices are actually more feasible than they were before. More and more business can rely on dynamic and interconnected systems to help improve internal processes and optimize flow. The future of lean appears to be strong and looks promising for as a key component in companies' strategy.

While lean is a founding school of thought, six-sigma methodologies along with other industry specific lean philosophies have been developed and continue to be developed so that firms can apply variations of the lean principles into their most applicable functionality. The idea of lean is not a passing craze, and lean principles will continue to be applied to various industries with the aim of maintaining flexibility and reducing unnecessary burdens from the firm's financial bottom-line while increasing the firm's customer service capabilities and maintaining employee satisfaction. Capabilities such as delivery speed, reliability, responsiveness and low cost distribution are considered critical components for sustained competitive advantage. But Ponomarov and Holcomb (2009) suggested that logistics capability qualifies to be a distinct capability, leading to sustainable competitive advantage, by reviewing characteristics such as added value, rarity and difficulty for imitating. Improving efficiency and effectiveness within a firm, especially in logistics, leads to long-term profitability and survival. Future research needs to deal with supply chain resilience that goes beyond JIT and six-sigma processes into the realm of strategic planning.

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